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III. NARRATIVE

1. Abstract

The **YES Networks Partnership** (the "Partnership") application seeks funding for assistance in establishing a new and unique type of educational satellite network which will provide services and benefits unparalleled by any other existing or proposed system. High-powered digital DBS (Direct Broadcast Satellite) signals received by small antennas (1.5' square), used with microcomputers offer perhaps the most impressive application of technology yet introduced to the classroom.

TV course lectures, computer course lectures (a new concept in course presentations), instructional materials, informational items, and other teaching and learning aids initially will be distributed via digital-based satellite transmission initially to schools in **Arkansas** and **Massachusetts** serving a high concentration of Chapter 1 students. Ultimately, the network will reach throughout the United States, serving public and private educational institutions, industries, libraries, homes, hospitals and other similar users with instructional needs **in all areas**. Instructional programming will initially focus on hypermedia and master teacher approaches to math and science, although the developed tools will also be applicable to language and vocational studies. This will be coordinated by the University of Arkansas at Little Rock (UALR) in cooperation with the Arkansas (ASDE) and Massachusetts (MSDE) Departments of Education. Engineering will be done in California by Advanced Communications Engineering, Inc. (ACE) and in Massachusetts at the Research Laboratory of Electronics of the Massachusetts Institute of Technology (MIT).

The Partnership project consists of four interrelated elements:

(1) Construction of prototypes to demonstrate feasibility and desirability of sending improved instructional courses and materials to Chapter 1 schools using digital DBS transmission;

(2) Development and demonstration of courseware optimized for use with real-time teacher-interaction for course origination and for downloading to classrooms for off-line use;

(3) Demonstrations and evaluations of courses using this new medium;

(4) Design of a user network that would meet national educational needs.

2. Project Description

Introduction - Education, and particularly distance learning, is rapidly approaching crossroads of historical proportions. The decisions made and directions taken in the next few years will set the course for decades to come. The famous statement, "the medium is the message," could not ring truer than when applied to the storage, propagation, and delivery of information, tools, and educational access, and particularly when applied to the system described in this proposal.

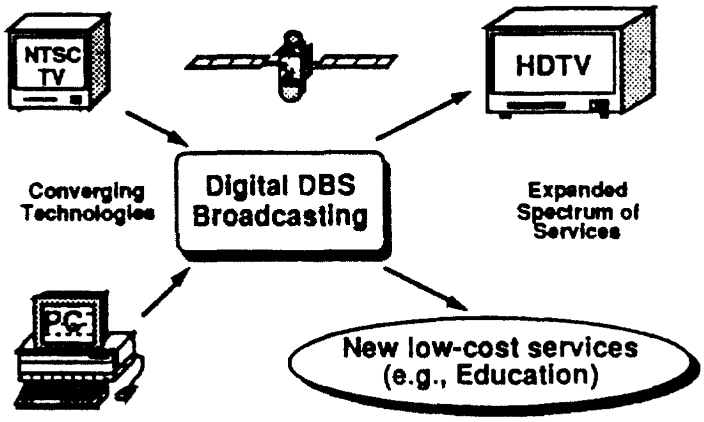

Figure 2-1 Converging Technologies —Expanding Services

The relevant, enabling event will be the advent of digital satellite broadcasts combined with the widespread use of personal computers for education, work, and recreation. Within only a few years anyone will be able to receive television, HDTV, digital stereo radio, electronic publications, and educational courses using a small antenna and a combined television and personal computer. High power digital DBS (Direct Broadcast Satellites) will allow economical reception and simple antenna set-up virtually anywhere.

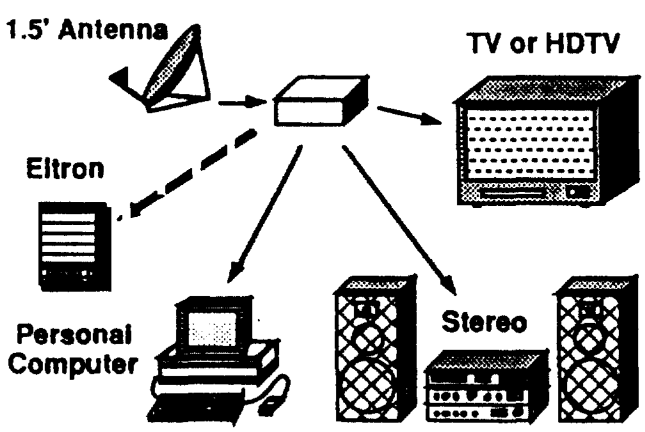

Figure 2-2 Receivers of DBS Services

While this Star Schools proposal is fully responsive to the stated purposes of the enabling legislation, it is unique. It may be the only one that will bring satellite distance learning into a completely new era — making possible an economical, unified system with capabilities far beyond any available today.

Early project emphasis — of necessity, more on the "system" rather than on course quantity — will ultimately benefit the entire distance learning community, including possibly all of the present Star Schools applicants. Therefore, we suggest that reviewers consider this project's broad significance and overall potential benefit to the educational community when evaluating this proposal according to the specified criteria.

(1) How the Project Meets the Purpose of the Statute

i. Objectives - The objectives of the Partnership's project are as follows:

(a) **To vastly increase the quantity and technical quality, while reducing costs, of nationwide satellite capacity for distance learning.** This objective will be reached by developing and integrating a combination of proven technology and techniques in audio, video, and computer facilities. Prototype transmission and reception units for broadcasting dozens of courses simultaneously will be designed and constructed by ACE, in concert with MIT evaluations. These designs will be extended to prepare for production capabilities for future widespread implementation.

(b) **To develop and acquire instructional programming and materials for use with these new facilities to improve instruction in mathematics, science, foreign languages, and vocational education.** The course materials will include both master teacher courses and math/science course materials which can be demonstrated by satellite broadcasts, specifically for schools in Massachusetts and Arkansas, and eventually to the entire nation. Both in-service and pre-service teacher training will be developed, to prepare teachers to create, customize, and implement hypermedia techniques into their instructional programs. Two specific course delivery types will demonstrate the operation of television displays and computer-integrated displays.

(c) **To demonstrate that satellite communications using digital transmission is an effective and economical means to apply proven technologies to student instruction and teacher training, specifically in Chapter 1 schools.** This objective will be met by (1) broadcasting these courses using the developed facilities in and for Chapter 1 schools, and (2) through expert evaluation of the results using an evaluation module which will assess quantitatively and qualitatively the effectiveness of the demonstration course and evaluate the cost-effectiveness of the digital facilities in comparison to conventional analog television.

(d) **To design a user network which will provide these enhanced services throughout the entire nation.** This digital network will overcome present limitations of satellite service availability and capability and can therefore benefit all users of satellite distance learning. The network will employ comprehensive, national, satellite-based communications system to originate, coordinate, and disseminate educational programming. The design will identify potential high-impact users, and will describe areas of informational and instructional needs to be met by the network.

ii. How Objectives Further the Purpose of the Statute - The Partnership project objectives are targeted directly for the program purposes cited in the statute. In fact, a multiplicative effect possible only with the application of the project's techniques to be developed will enable reaching the statute's objectives more economically and quickly than any known similar application of present-day, analog deliveries.

- **Capacity** - Insure that adequate satellite course transmission capacity will be available to meet the needs of the near and more distant future for all types of courses with emphasis on math, science, foreign languages, and vocational education;

- **Economy** - Substantially reduce the cost of providing both teacher training and student instruction by fully utilizing the capacity of satellite transponders through digital techniques; and by making possible the use of very small receiver systems that are easily mounted on any building structure, including indoors;

- **Flexibility** - Enhance the widest use of the transmission capacity by offering superior video quality when it is needed, and by transferring supplementary materials that can be interactive and used off-line by both students and teachers;

- **Accessibility** - Expand the penetration of valuable courses into areas where special-area instruction is not otherwise possible because of isolation, funding, transportation, available time, or other reasons; and to the handicapped, the migrant worker, the prison student, and to the industry worker who simply cannot otherwise find the means and time to improve skills and personal facility with everyday tasks. The multiplicity of courses on each satellite transponder and the low cost of the receiving terminals make this augmented accessibility possible.

We believe that the opportunity to effect the most dramatic advances in instructional results through the American educational system is at hand. The Partnership project proposes to take the first steps toward creating a national user network for American education, and therefore could be the most significant of the applications submitted under the Star Schools program.

(2) Extent of Need for the Project

i. Needs Addressed by the Project - The critical needs of America's educational system are well known, including the need to **improve access of Chapter 1 schools to mathematics and science instructional materials** which are at present available only to districts with superior financial resources. In many cases the target Chapter 1 schools are found in the poorest of districts, whether inner-city or rural, and have a student population characterized by a high concentration of educationally deprived students.

Distance learning has been proven effective and has been growing at a rapid pace. As noted by Dr. Frank Withrow, "It is possible to use these technologies to reach very isolated students, i.e., handicapped homebound students, students in prisons, students on Indian reservations and even students who are in the workplace."[1]

However, the growth of distance learning may soon be stymied by delivery costs, lack of related capabilities (e.g., little or no capability to down-load supplementary materials, limited interactivity), and especially a **shortage of affordable satellite transponders.**[2] This shortage has been exacerbated by extensive delays in the launch schedules for communications satellites due to the technical problems that have faced the space shuttle program. Current analog transmission and reception techniques are capable of producing only one or two signals per transponder. There is an obvious need to optimize the capabilities of current and future satellites to ensure that each transponder can simultaneously broadcast as many signals or programs as possible.

Students need more than audio/video lectures. Real-time interaction and off-line study can only be effectively delivered by a digital broadcast medium. Some of today's satellite distance learning systems have a low data-rate digital capability which allows text to be printed at remote sites. Much higher data-rate capabilities than now available are required to allow downloading of computer-interactive course materials for use during and after the class period.

The project will demonstrate how, by greatly reducing acquisition and dissemination costs, the introduction of a new technology will expand access of these students to a wider variety of new and improved educational materials and unusual resources, such as exposing them to master teachers from across the country recognized nationally for their instructional excellence.

Teachers should be involved early both in the human interface design of the system and, of course, in the trial content and delivery portion of the project. In-service teacher training is a necessity for successful implementation and acceptance of any new service. The ability to deliver such training is an inherent capability of the YES Networks' system

In addition, two technical standards for digital DBS are yet to be established — transmission format and video compression. Advanced Communications Corporation's (ACC) premier position in the DBS industry and its commitment to the Foundation for Educational Advancement Today (FEAT) and the YES Networks' pioneering endeavors will guarantee that capabilities for the described educational services will be included in any such standards. However, there is a need for an early trial system to be placed in service using an existing Ku-band satellite to provide a test bed for the service. Parts of this system could be retrofitted onto existing Ku-band systems. However, the full benefit will be realized only when it is implemented via a true, mass-market DBS system. To assure that the voice of the educational community is heard and that education is not slighted in developing new standards, early trials of such a system are essential.

ii. How the Needs were Identified - During the Spring of 1987 (pre-dating the Star Schools authorization), discussions were undertaken with a number of national educational organizations interested in improving access to educational resources — the central issue addressed by this proposal. Subsequently, a literature survey was conducted. Reports such as *The Governors' 1991 Report on Education, A Time for Results* - Task Force on Technology; and the National School Boards' Association, *A National Imperative: Education for the 21st Century*, made clear the concerns of many educators regarding the need to introduce new methodologies and technologies into education. Conversations with numerous state and federal officials reiterated support of technological applications in the classroom to broaden access to educational resources. Yet, nearly everyone also repeatedly stressed the **high costs associated with the conventional hardware** and available programs, and the **absence of a centralized, unifying network** to schedule programming and coordinate user interests.

More recently, Congress's Office of Technology Assessment (OTA) has completed its description and evaluation of technologies that are available for classroom use today: *Linking for Learning — a New Course for Education*;[3] and *Power On — Tools for Teaching and Learning*.[4] Explicitly evident was the consensus that **if the costs can be reduced,** technology as a tool can and should be used to transform the classroom environment and the learning experience in revolutionary ways. The realization of this widely-held consensus and the challenges posed by the apparent universal desire to create a user network led directly to formulation of the Partnership project.

In other areas, research is clearly demonstrating that American school children at all grade levels perform poorly in math and science on achievement tests in comparison to students from other industrialized nations (Antonopolis, 1985[5]; Ferko, 1989[6]; International Association for the Evaluation of Educational Achievement, 1988[7]; McKnight, 1987[8]; Riddle, 1986[9]). National concern over the poor performance of United States students in mathematics and science is reflected in calls for a restructuring of our educational systems.

In most elementary classrooms, mathematics and science education currently consists of little more than drill and practice and the memorization of facts. Curriculum experts are now encouraging teachers to foster "thinking" or the integration of knowledge and skills as well as learning computational skills and facts. Numerous researchers have demonstrated a wide variety of effective instructional strategies to improve science and math skills.

However, several barriers exist to implementing the needed changes. These include: teachers being poorly prepared to provide science and math instruction; current text and workbooks not containing sufficient material to allow students to develop and practice higher-order thinking; and computers primarily being used to provide drill and practice of basic facts.

Borchardt (1987)[10] surveyed 218 elementary teachers, who ranked the impediments to teaching in the elementary schools. The most significant problems were: (1) inadequate set-up time; (2) inadequate preparation time; and (3) equipment deficiencies. Tobin (1987)[11] found that the most prevalent problem related to elementary and high school math and science teaching strategies was associated with inadequate content knowledge. Bloom (1976)[12] surmised that 25% of the variance in school success or failure could be attributed to how students felt toward what they were studying, their environment, and their concept of self. Similarly, another 25% of the variance in school achievement was attributed to quality of instruction. He proposed that attitudes and quality of instruction were more alterable variables and should be the target of educational reform. Researchers clearly support this hypothesis. For example, Simpson and Oliver (1990)[13] found that science curriculum and practices in our elementary and high schools are collectively producing students with a poor attitude towards science, and that they typically avoid courses beyond the basic minimum requirements.

iii. How the Need is to be Met - Improving the access of the target Chapter 1 schools to enriched educational resources can be accomplished through the creation of a comprehensive, national network of users who are linked via satellites. However, this is not currently possible through conventional satellite systems due to the high costs of the necessary hardware and software, beyond the reach of most school districts. By applying today's advanced technology, all schools could benefit, and financially disadvantaged schools especially could tap resources that currently are beyond reach. Three elements are required to make the network possible:

(1) An efficient, cost-effective technology for disseminating the instructional and informational materials;
(2) An organization to manage the exchange of ideas and resources;
(3) The financial capacity to enable many users to participate relatively quickly after formation of the network.

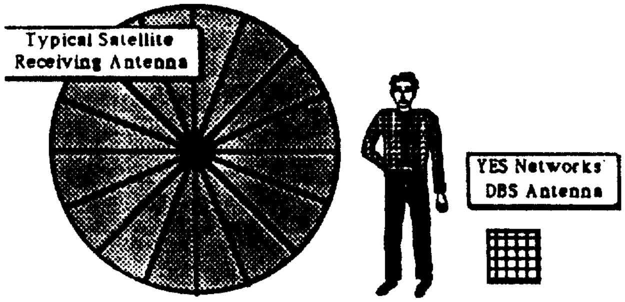

Figure 2-3 DBS Antenna Size Comparison

Two years ago, when the Star Schools program began,[14] the future of DBS was not as certain as it is today. Also, most DBS operators had planned to use analog TV transmission—the method that is presently used exclusively for standard television on today's domestic low-power satellites. Advanced Communications Corporation's leadership[15] in promoting digital DBS[16] has now been validated by a virtually complete industry turnabout. For example, the Hughes-Murdoch-NBC-CableVision consortium announced in February of 1990 that it would follow ACC's lead and proceed with construction of a digital DBS system.

The relevance of digital DBS to distance learning, and Star-Schools-type projects in particular, cannot be overemphasized. It will bring unparalleled flexibility, efficiency, and economy of operation to educational course broadcasting. It will allow introduction of a vast number of **new educational services never before possible**—all received with antennas convenient to install because they are not much larger than a student's opened notebook. The system proposed by the YES Networks Partnership **will assure the future economic availability of adequate satellite delivery capacity** for traditional-type distance learning for the entire nation.

The proposed system will be used for actual distance learning and will be available for research by the educational community. The results of these trials will determine the general directions for full implementation of the nationwide YES Networks on-board ACC's digital DBS system.

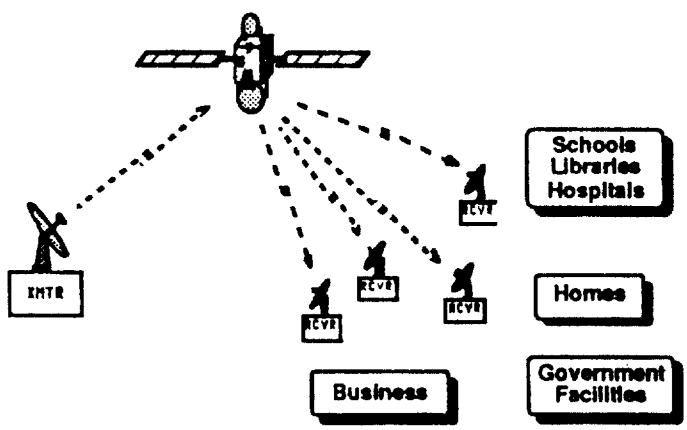

Figure 2-4 Broadcast Satellite System

The envisioned services are part of a

satellite broadcast network such as that shown in Figure 2-4. A ground station up-link provides a multiplexed digital signal which is re-broadcast from the satellite to multiple receive-only ground stations located at individual schools, businesses, or homes. A large number of services can be offered simultaneously by the YES Networks within one satellite transponder (channel) as illustrated in Figure 2-5. This is currently impossible using existing analog transmission. Many of these services will be readily available to anyone while others may have restricted access and even security encryption if desired.

There are also rapid advances being made in the area of control software for computer-related services. The most useful of these is hypermedia software such as HyperCard™ or Linkways™ which give instructional developers extremely powerful tools for creating high quality multimedia-based instruction and the capabilities to modify the instruction virtually instantaneously to meet the needs of specific individuals or groups. For example, a master teacher with access to hypermedia controlled video disk or CD technology could, in response to a student's question, illustrate the germination of a seed with high quality video or animation without having to do any advanced preparation. These development environments make it extremely easy for instructors to control the presentation of textual, audio, and graphics based information stored on a wide variety of mediums including CD players, laser disk players, and VCRs.

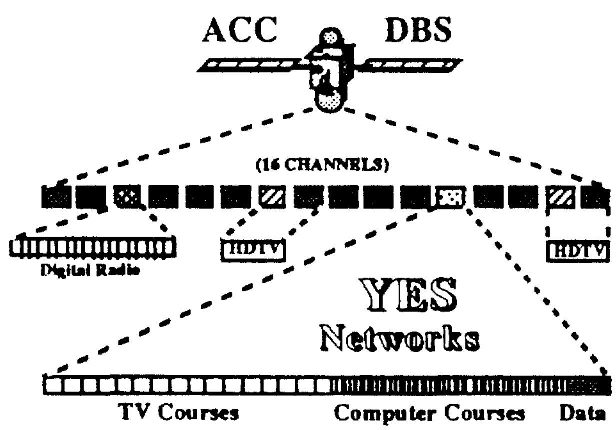

Figure 2-5 Digital DBS Services

A more recent trend is the ability to display live TV images within a "window" on the computer screen. Using inexpensive computer cards now available, inserting an instructor's TV image, or a video segment illustrating a concept, into the corner of a computer-displayed graphic screen is now relatively easy to implement. 24-bit color display capability will support superior full-color TV images and is rapidly becoming the standard on the Macintosh, and soon will likely be so on all PCs.

Two basic types of services are proposed. One is a **TV Course** service which is functionally similar to that being offered today, but is far more transmission-efficient, far less expensive, and has the flexibility of including additional services such as printed output and high-quality, on-screen graphics. The other is a **Computer Course** service which is even more efficient and less expensive than the TV courses, but still can be displayed on TV monitors or an overhead projector using a computer adapter. The Computer Course also has vast additional capabilities that cannot be offered by any of today's TV course transmissions.

Some of the preliminary work already has been described in the proposal[17] and final report[18] for a contract that ACE performed for NASA Headquarters and the Public Service Satellite Consortium, in which ACE examined the utility of ACTS[19] for educational broadcasting. While using new proprietary techniques and designs, the proposed project is well-grounded in proven technologies and is therefore low-risk. The needed basic technology is available today and is cost-effective.

In addition, the Foundation For Educational Advancement Today (FEAT) has informed the Partnership that if the utility of digital technology can be demonstrated in the classroom and a user network designed, the Foundation will pledge in return to contribute two transponders donated by ACC and the receiving equipment for all of America's public and private schools and libraries and assist the founding and operations of the YES Networks' national educational system.

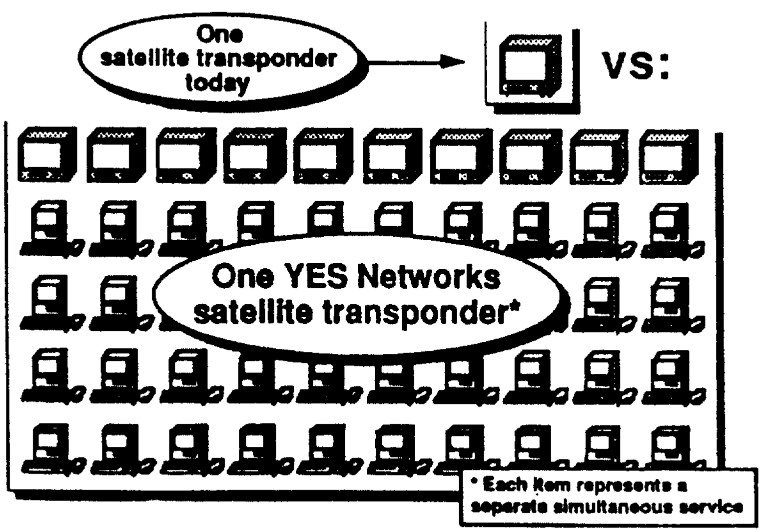

Figure 2-6 Comparison of Services

A potential solution to some of the nation's educational problems is to use the expertise of a master teacher or curriculum specialist to develop and present high-quality lessons to a very broad audience. These specialists would exhibit exceptional teaching strategies, superior motivation and communication skills, sound curriculum knowledge, interpersonal competence, and classroom management proficiencies (Allen, 1987[20]; Coughlin, 1986[21]; Klein, 1985[22]; Lawrence & McCreath, 1988[23]). Unfortunately, there is a shortage of teachers possessing master teaching competencies in mathematics and science (Bell, 1983[24]). This is particularly true in rural or small school districts where traditionally it is difficult to attract teachers with specialized skills.

One immediate strategy to meeting this shortage is to use distance-teaching technologies to share the master teacher among many schools and classrooms (Ewell, 1982[25]). Distance-teaching techniques transmit instruction from one location to multiple, geographically separate locations. A large number of distance teaching strategies using telecommunications technologies (e.g., satellite transmission of courses and live interactive video teleconferences) as an educational tool to increase teaching resources and expand educational opportunities have been demonstrated (Benson & Hirschen, 1988[26]; Kitchen & Kitchen, 1988[27]; Pease, 1989[28]: Withrow, 1990[29]). These techniques can provide an effective alternative to traditional forms of instruction in terms of student satisfaction, content mastery, and cost effectiveness (Wilson, 1989[30]).

Network science is a new approach to science and mathematics teaching and learning that uses telecommunications technology to connect classrooms around the world (Kapisovsky, 1990[31]). Students participating in the network science projects work collaboratively with their peers to investigate compelling science and mathematics problems. Using telecommunications networks, the students send results of experiments to a central computer which pools the data and sends back the summaries. A number of software tools, such as graphing software, are provided to the students to use in their experiments. The network science approach has proven to be a successful strategy for improving student's mathematics and science skills both in the U.S. and abroad. Building new learning environments for students and teachers by incorporating innovative curricula with powerful instructional technologies is an important step towards solving our educational problems.

In addition to telecommunication technologies, microcomputers have revolutionized distance education in virtually every area. Used alone, microcomputers can provide students and teachers with a wide range of instructional activities and productivity tools. When connected to local or distant networks, microcomputers can facilitate communications between students and teachers, and provide access to vast storehouses of information.

One of the most exciting advances in educational computing is "hypermedia" which is the ability to connect text, graphics, animation, relational databases, motion video, and sound into a single environment, coupled with the ability to jump as needed from place to place in an intuitive manner. This involves combining microcomputers with video disc, CD-ROM, video tape, sound digitizers, printers, video displays, and other data storage and output technologies. For example, while viewing an illustration of a blue jay, the student could simply click on an icon of a musical note to hear a blue jay's call, or click on an icon of a wing to see a video segment of its flight. The student could then click on the blue jay's species name to see an illustration or listing of related birds. Any of this information could be "spoken" by the computer or presented in a written form in any language desired. No instructional tool other than a computer, not even a skilled teacher, could offer the sequence of control, user-adjustability, progress tracking, and patient repetition available through hypermedia (Jaffe & Lynch, 1989[32]). Hypermedia makes new forms of educational experiences possible and more powerful. This is particularly important for reaching students at risk, and "visual learners" who have extensive experience watching television, videos, and playing computer games.

Although there is a variety of very powerful tools, such as HyperCard and LinkWays, that enable virtually any one to design hypermedia based educational activities, in many ways these tools make instructional design more complex because there are more variables to consider such as sound, animation, video, and navigational links. Hypermedia materials should be student-centered, and should rely on generating conditions to encourage natural learning processes, questioning, and exploration. Materials need to be designed to pique and sustain the student's interest. Teacher in-service and pre-service training programs are needed to prepare teachers to use hypermedia technologies and to participate in the instructional design processes.

In addition to improved instructional programs, hypermedia technologies provide extremely powerful tools for teachers to provide information in a wide variety of formats and to answer virtually any question "on the fly". One example of this concept is PODIUM (Hofstetter, 1989[33]).

PODIUM provides teachers with a powerful yet uncomplicated multimedia lecture tool. After creating an outline the software automatically creates a presentation display that lets the teacher access instantaneously any slide , computer graphic, animation, video, or sound through a touch screen. In addition to integration tools, this technology allows teachers to conduct immediate searches of computerized data resources, such the Grolier Encyclopedia on CD-ROM. The availability of instructional tools such as this will enable teachers, particularly master teachers, to provide superior instructional opportunities for all students.

Comparison	Present Systems	YES Networks
Recipients of Services	Schools, Businesses	Schools, Businesses, Homes (also mobile), Hospitals, Libraries
Receiver Antenna Size	8' diameter	1.5' Square Plate
Local Zoning for Antenna	Very Restrictive (Often Prohibitive)	Not Restricted (Preempted by FCC)
Installation	Construction, Pedestal, Sometimes Needs Fencing	No Construction or Pedestal, Set up Indoors Through Window or Skylight
Types of Services	TV Lectures	TV Lectures, Computer Lectures, Written Materials, Teacher Aids, Remedial/Advanced Programmed Learning, Interactive HyperMedia
Simultaneous Courses in One Satellite Channel	One (Possibly Two)	100 (Estimated)
Satellite Transmission cost of one Course	100% (Reference)	1% to 5% (of Reference)
Flexibility of Service	Very Limited	Extremely Flexible
Support for Interactivity	Only by Telephone Line	Classroom System Interactivity Both During Broadcasts and Off-Line

Figure 2-7 Service Comparison Table

This project will develop high quality distance teaching approaches using master teachers, realistic simulations, and problems solving situations emphasizing integration and application of knowledge, and state-of-the-art hypermedia techniques for obtaining and sharing information.

Once such a system is created and implemented through a network of users, there would be little reason for any school to be deprived of access to an extraordinary inventory of educational programming far in excess of that now available only to the wealthier districts. This advance in educational access would be possible not only by introducing new hardware, but also through the pooling of resources in a user network.

Figure 2-7 shows in comparative form how the YES Networks digital DBS system will better meet the needs of the distance learning community well into the next century.

iv. Public Benefit from Meeting the Need - The public benefits to be derived from meeting the need for improved access to instructional and informational materials are legion. One might compare today's access to educational resources enjoyed by most schools and the potential for an effectively-administered, digital-based satellite communications network with the increased access to information created by Gutenburg with his movable type revolution. With Gutenburg's invention, costs fell, the dissemination of ideas exploded, and learning was made available to a vastly expanded audience. Similarly today, while technology cannot replace the human resource in the classroom, it can greatly expand teachers' inventory of educational materials and their effectiveness with students.

The types of programming which can be relayed through digital transmission are virtually unlimited. One satellite transponder (of many on each satellite) can blanket the United States with perhaps one hundred programs. This extraordinary variety is brought by digital technology and video compression making possible many applications which at present are beyond the reach of the current systems.

Following are only a few of the more obvious educational and other services which would benefit the public as a result of implementing the proposed system:

- Improved delivery of such programs as "News Access," a weekly service pioneered by NASA and Turner Broadcasting (CNN) to improve the work of teachers;
- New programming such as "Science & Technology Access "or "World Cultural Access";
- Educational programming to all of America including Puerto Rico and the Virgin Islands;
- Relay of educational programming to Department of Defense-operated schools;
- Much improved access of rural schools to educational programming;

- The Department of Education could enable transmission of informational and innovative materials to all schools almost instantly and inexpensively;
- Better programming to vocational-technical schools, learning libraries, industries, and families and individuals;
- In-service training to teachers;
- Better service to the migrant student network;
- Support of the Job Corps and other federal programs;
- U.S.D.A. market data and information exchange;
- Student record tracking of achievement scores and health records;
- Senior citizen learning opportunities.

The demonstration of feasibility of using digital-based communications in education and the lower per service costs and increase capability of such a system will be the most persuasive argument for creating a network of users founded in public and private schools and libraries.

(3) Plan of Operation

i. Proposed Project Design - The Partnership project will be coordinated by FEAT with specific tasks allocated to the other partners. The overall administrative and fiscal responsibilities would also be vested in FEAT.

Engineering tasks, principally the construction and evaluation of specialized digital equipment for transmitting and receiving courses and the supporting operating system software, will be performed for the project by Advanced Communications Engineering, Inc. and the Massachusetts Institute of Technology. Faculty from the University of Arkansas at Little Rock, staff from Learning Express, Inc., and panels of national experts will design the hypermedia-based software and procedures for mathematics and science courses that will be used in the classroom demonstrations. These professionals will also help develop and evaluate the teacher training programs.

Through a cooperative agreement, the project will use the expertise of the **Math and Science Together (MAST)** Program staff and its committees of expert consultants to identify and develop appropriate educational materials in math and science, and help identify master teachers who will deliver the broadcast instruction. In 1989, the University of Arkansas at Little Rock in cooperation with the Arkansas Partners in Education, a non-profit agency of the Arkansas Governor's Office was awarded a four year grant from the National Science Foundation to implement a model education program for math and science in the state of Arkansas. The project included the following components: (1) expansion of a successful existing out-of-school program in mathematics, consisting of curriculum individualization, enrichment and problem solving and use of microcomputers, to an in-school program serving a wide range of ability levels; (2) integration of science instruction into an expanded mathematics model; (3) development of curricula and support materials for this integrated math/science model program; (4) incorporation of computer technology and the use of calculators into the model program and teacher training.

ASDE and MSDE will aid UALR in evaluating the instructional course material selected for the classroom demonstrations, and will contribute to the development of an evaluation module to assess the results. ASDE and MSDE will recommend Chapter 1-eligible schools for implementation of the classroom test. FEAT will design the organizational and financial plan for the YES Networks, identify its potential members, assess its benefits, and characterize programming needs.

The tasks can be broadly divided into four areas: (1) Demonstration Equipment, (2) Course Preparation, (3) User Network Design, and (4) Assessment and Evaluation.

1.0 Demonstration Equipment

The technical portion of the project is structured so that the initial twelve months of requested funding will result in classroom demonstrations of operational equipment for Computer Courses. Specifications for TV Course production receivers will also be a product regardless of the availability of additional second year funding appropriations. If funding is obtained for a second twelve months grant period, a TV hardware prototype will be constructed.

The relatively short schedule is possible because of previous experience,[34] completed design work (e.g., an innovative digital demodulator, designed for integrated circuit implementation), and the deliberately robust system design, allowing many program elements to proceed in parallel before final integration. Most of the hardware work will be done in southern California. Compression algorithm simulations and evaluations will be done at MIT's Research Laboratory of Electronics in

Cambridge, MA using facilities and equipment of the Advanced Television Research Program. Detailed task-dependency and corresponding project schedule charts are included in Appendix C.

Demonstration Equipment subtasks are as follows:

1.1 - Operating Software. This subtask will develop the software necessary to operate the hardware developed for the classroom demonstrations.

1.2 - Transmitter Prototype. This subtask will develop the specifications for manufacturing the transmitter equipment, will produce a prototype transmitter, assemble the equipment and test the equipment prior to the demonstrations.

1.3 - Receiver Specifications. Specifications for receiver equipment will be produced.

1.4 - Receiver Prototype. Receivers used in the demonstration will be assembled and tested.

1.5 - Digital TV Specifications. Simultaneously with the development of the digital equipment for transmission and reception of the computer demonstrations, digital TV equipment specifications will be developed. At the end of the first project period (12 months) specifications for the compressed digital TV will be completed.

1.6 - TV Prototype. During the second year, a TV prototype will be constructed and demonstrated. This equipment will be the major product from the second year of the project. No funding is requested for TV prototype manufacture during the first year.

1.7 - Equipment Assembly and Service Trials. Equipment field trials using satellite transmissions will be conducted by ACE prior to the demonstrations in test schools.

2.0 Course Preparation

2.1 - Review Existing Curricula. Project staff will conduct a thorough review of existing mathematics and science curricula, and evaluate for use with telecommunications technologies. Existing Star School and other telecommunication-based educational projects will be examined to identify curricula strengths and weaknesses. An Advisory Committee will be formed consisting of outstanding scientists and mathematicians to provide advice and guidance on the project task. These activities will be coordinated with the aforementioned MAST project (e.g., the Advisory Committees for the two projects may share many of the same members).

2.2 - Develop Hypermedia and Digital Broadcast Laboratory. At the College of Education of UALR, a hypermedia development and digital broadcast laboratory will be developed to create, disseminate (i.e., broadcast) and evaluate the project's instructional materials. This laboratory also will be used to develop and conduct teacher training activities.

Selection and purchase of specific equipment will be based on equipment needs identified in the review. It is envisioned that at least five workstations will be procured for the laboratory to develop and test hypermedia instructional packages. These workstations will consist of powerful microcomputers, color monitors, hardware capable of digitizing color video images and sounds, networking hardware and software, color projection system, video disk players/recorder, compact disc players/recorders, high density storage systems, video cameras and recorders, printers, electronic sketch pad, software for creating hypermedia and print materials, and the digital broadcast link.

A model hypermedia and digital reception workstation also will be designed and assembled, for use in classrooms. These stations will consist of a computer and monitor, digital interface card, videodisc/CD-ROM player, networking hardware and software. Each demonstration classroom will be equipped with ten of these stations. The teachers' systems will be similar, except that they will also include a modem, projection pad, software and hardware to monitor the activities of each student workstation, and software for hypermedia development and tracking student progress.

2.3 - Produce Integrated Curricula Materials. The overall goals of the instructional modules will be to increase the students' beliefs that mathematics and science are valuable to themselves; to increase the students' skills in mathematic and scientific reasoning; to increase the students' abilities to read, to write, and to speak about mathematics and science; to increase the students' skills in using mathematic and scientific procedures to solve problems; and to develop the students' confidence in using of mathematic and scientific procedures to cope with the demands of life.

Following the aforementioned curricula review, the project staff will create and modify four integrated math and science instructional modules which will include the incorporation of successful interactive videodisc and hypermedia programs, such as Videodiscovery's *Life Cycles* and NOVA's

Animal Pathfinders videodisc and stackware, and hands-on instructional packages and practical experiments. The modules will be designed to use math and science concepts and techniques to solve realistic problems. They will stimulate the use of technologies to answer questions posed by the students, who will be active participants in the learning process.

The curricula development process will include four steps. The first will be the development of specific instructional objectives, and the component steps needed to achieve these objectives. The resulting plan will be reviewed by the Advisory Committee. Based on the Committee's recommendations, the plan will be modified and a working prototype of the modules will be created. These prototypes will be reviewed by both the Committee and representative teachers from the participating schools. The final step will involve the development of the instructional modules that will be used in the demonstration. Based on evaluations, the modules will be revised and expanded into complete curricula packages during Year Two.

2.4 - Review Related Teacher Training. Project staff will conduct a thorough review of existing programs for training teachers to use distance learning and hypermedia technologies. This will include literature searches and data-gathering visits to model programs. In particular, existing Star School and other telecommunication-based educational projects will be examined to identify curricula strengths and weaknesses.

2.5 - Create and Evaluate Teacher Training Programs. Teacher training will take two forms: graduate level coursework and staff development training. Courses will be developed using information derived from the aforementioned review and in consultation with the Advisory Committee. As much as possible, the training programs will be designed to use the same hypermedia processes and technologies as the math and science modules. The project will provide participants with intensive training, opportunities to observe development and implementation activities, and monitored practice activities. All demonstration site teachers and their administrators will be encouraged to participate in this training. As noted, Hypermedia workstations will be located in each targeted classroom for use by the teachers and administrators. Approximately 20 UALR graduate students will also participate in the training program as part of their graduate coursework.

Based on the evaluation of the training program provided by Year One participants, the training program will be modified and standardized for use by a larger number of teachers and graduate students in Year Two of this project.

3.0 User Network Design

The YES Networks will be designed by FEAT. The principal product will be a detailed plan for the creation of the network. Subtasks are as follows:

3.1 - Review Existing Programs. Existing cooperative public and private educational programming and networking ventures will be examined to determine the extent of such activity nationally, and assess the strengths and weaknesses of current efforts.

3.2 - Survey Of Users. A written survey instrument will be developed for assessing the attitudes of educators, manufacturers, potential users, and others toward the availability of educational resources. Qualitative analysis techniques will be used also as a follow up to explore the implications and results of the written survey. Assistance from the EAB will be prominent.

3.3 - Inventory of Needs. Based on the results of the surveys from subtasks 3.2 and the assessment conducted in 3.1, an inventory of educational needs which might be addressed by a user network will be compiled.

3.4 - Network Design Characteristics. The inventory of needs will contribute to an assessment of the characteristics which would be desirable in a successful user network. The description of these characteristics will be reviewed by advisors to the project.

3.5 - Alternative Designs. Several alternative designs for a user network will be developed. Designs will include organization, funding, programming resources, coordination, scheduling, and other elements which a functioning network would have to include. These alternatives will be reviewed by the groups advising the Partnership and others.

3.6 - Recommended Design. From the assessments and reviews described above, a recommended design for a network will be produced. The details of the design will be such that the creation of the network would require only the commitment of groups identified as necessary to implement the plan.

4.0 Assessment and Evaluation

The success and beneficial impact of the project will in part depend on credible evaluations of whether the objectives of the project were met. If the user network is to become a reality, and digital technology is to be introduced on a serious scale into the schools of America, the results of a successful demonstration must be reported accurately and impartially. Subtask are as follows:

4.1 - Hardware Evaluation. A group of experts in satellite and computer hardware design has been assembled for work in the proposed Partnership project. Their responsibility will be to evaluate independently the ability of the technology to perform in a realistic demonstration. They will assist in the assembly, field trials, and testing of the equipment under classroom situations.

4.2 - Chapter 1 School Selections. The Chapter 1 Schools coordinators for Arkansas and Massachusetts, assisted by UALR, will recommend schools for implementation of the digital technology demonstration. These schools will be chosen to represent elementary and secondary schools. Although most will be characterized as Chapter 1-eligible, baseline, non-Chapter 1 schools (2 - 4 out of 20) will be selected for inclusion in the demonstration for comparison purposes.

4.3 - Analytical Methodology. UALR will prepare an assessment module for evaluating the classroom demonstrations. The methodology will include both quantitative and qualitative approaches. The mastery of the operating instructions and assimilation of course material will be measured through performance times and achievement tests. The performance results of Chapter 1 schools students and teachers will be compared with those of non-Chapter 1 schools.

4.4 - Review Teacher Training Instructions. UALR, ASDE, and MSDE assisted by advisory groups will review the instructions developed by ACE for use of the digital equipment in the classroom demonstrations to insure that they are clear, concise, and instructive.

4.5 - Quantitative Analysis. The instruments measuring performance times and achievement will be administered during the classroom demonstrations and the results analyzed by UALR.